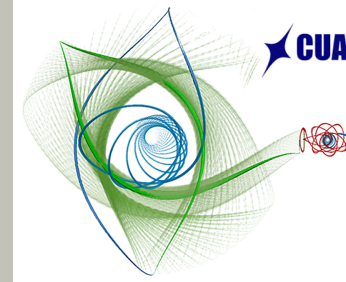## Project Introduction

CU Aerospace (CUA) proposes further development of the **Dy**namically **L**everaged **A**utomated **(N)** Multi- body Trajectory Optimization (DyLAN) tool, which solves impulsive and low-thrust global optimization problems in multi-body dynamical regimes, and can do so in an automated fashion. NASA and commercial entities are in need of advanced methods that allow for rapid analysis of complex trajectory optimization problems, so that the most informed decisions with regard to mission design can be made at an early stage in the planning process. This includes having a solver that can intelligently search the large problem space, do so quickly, and with a great enough level of fidelity to ensure that the trajectory can be continued to a flight fidelity level. Advanced optimization tools for the LT multi-body problem do not currently exist, yet this regime is seen in numerous mission designs. During Phase I, CUA will combine recent ad- vances in global optimization, such as hybrid optimal control frameworks and intelligent heuristic global solvers, with robust and efficient local optimization and medium-high fidelity modeling of launch vehicles, spacecraft, and engine modeling to advance DyLAN to fill the aforementioned needs. Phase I efforts will include parallelism, both for personal computers and large compute clusters, to reduce run-time. Lastly, in Phase I, an automated export capability of solved solutions to NASA's flight fidelity solver GMAT will be implemented; thereby providing an efficient global optimization capability to GMAT for multi-body, which does not currently exist. The aforementioned capabilities will be demonstrated with select test problems by CUA. DyLAN is the next logically tool for a mission design team that current uses NASA's EMTG for interplanetary and GMAT for flight fidelity solutions.

Anticipated Benefits

DyLAN addresses an existing preliminary mission design problem that currently requires a human-in-the-loop; extremely inefficient and mission limiting. DyLAN will meet NASA's Technology Roadmap goals of advanced modeling and simulation tools that allow for expanded solution spaces enabling new design concepts while decreasing cost with higher fidelity, efficient simulations. DyLAN goes beyond these goals by connecting NASA EMTG and GMAT into a highly productive and maintainable design toolchain.

DyLAN's early demonstration proves that commercial entities (e.g. a.i. solutions, Lockheed Martin, Orbital ATK, the Aerospace Corporation, KinetX Aerospace etc.) using DyLAN for bids on science/defense missions, or as contractor to NASA for multi-body problems (libration point, resonance transfer, departure/arrival) will possess a strong advantage over competition. DyLAN provides the only avenue for entities (commercial/academia) without world experts to design and optimize such missions.

Dynamically Leveraged Automated N-Multibody (DyLAN) Trajectory Optimization, Phase I
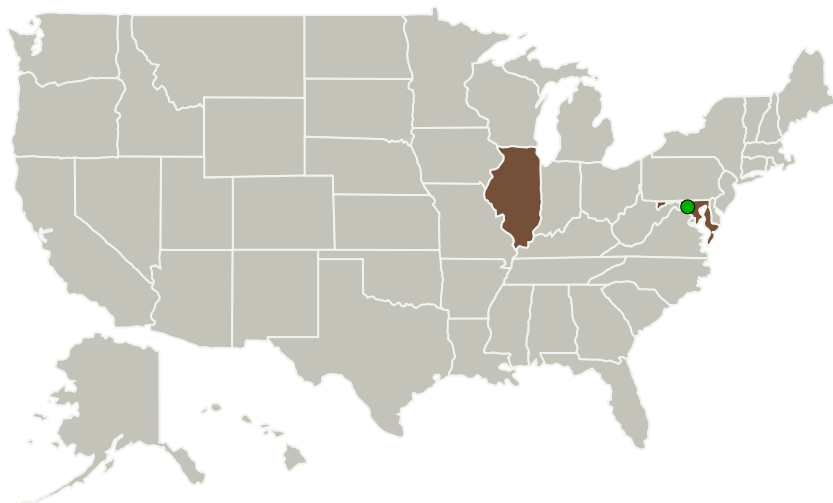
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Primary U.S. Work Locations and Key Partners

Organizations Performing Work	Role	Type	Location
CU Aerospace, LLC	Lead Organization	Industry	Champaign, Illinois
● Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations	
Illinois	Maryland

Project Transitions

▶ July 2018: Project Start

✓ February 2019: Closed out

Closeout Documentation:
- Final Summary Chart(*https://techport.nasa.gov/file/141329*)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

CU Aerospace, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

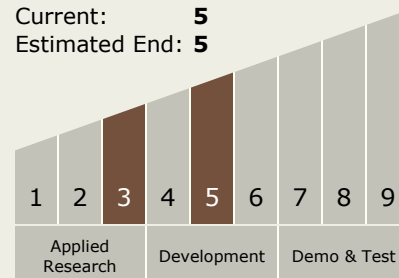**Program Director:**

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Ryne Beeson

Technology Maturity (TRL)

Start: **3**
Current: **5**
Estimated End: **5**

1	2	3	4	5	6	7	8	9
Applied Research			Development			Demo & Test		

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Images

Briefing Chart Image
Dynamically Leveraged Automated N-Multibody (DyLAN) Trajectory Optimization, Phase I
(https://techport.nasa.gov/image/135579)

Final Summary Chart Image
Dynamically Leveraged Automated N-Multibody (DyLAN) Trajectory Optimization, Phase I
(https://techport.nasa.gov/image/133454)

Technology Areas

Primary:

- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
  └ TX05.2 Radio Frequency
    └ TX05.2.1 Spectrum-Efficiency

Target Destinations

Earth, Foundational Knowledge